

## g18 Nevadan orogeny < batholiths, gold, melange, Sundance, Morrison >

Even a blind hog can find an acorn.

—(Ozark) proverb.<sup>1</sup>

### Sutter's Mill and the forty-niners

'This day some kind of mettle was found in the tail race that looks like goald,'  
Henry Bigler, a Mormon worker at the mill, wrote in his diary.<sup>2</sup>

Gold was found in California by James Marshall on January 24, 1848, in the tailrace of the sawmill that he built for John Sutter: Two tiny nuggets, the first the shape and about half the size of a pea. The gold rush which followed yielded by 1853, from the Sacramento drainage basin, \$200 million in placer gold. The gold is worked out today (**Footnote g 18.1**). From where upstream the gold came has not been located. Possibly, long since removed by erosion, its source (the mother load) was a rootless, low-grade epithermal (i.e. formed at shallow depths to about 1 km and at low temperatures of 50° to 200°C) deposit related to the granite batholith of the Sierra Nevada divide—such are common products of volcanic hydrothermal activity in present-day island arc settings.

### Nevadan orogeny (Late Jurassic climax)

The western part of the Cordilleran mobile belt underwent an orogeny called the *Nevadan*. Major events were: 1) igneous activity that ended Early Cretaceous and began Late Jurassic (the associated volcanoes are long gone but deep erosion now exposes their root batholiths in the Coast Mountains of Alaska and British Columbia, Cascade Mountains of Washington, Idaho Rockies, White, Klamath, and Sierra Nevada mountains of California, and Baja Peninsular Ranges), 2) accretion of an island arc (the Franciscan fm) and, 3) deformation of Lower Cretaceous and Upper Jurassic sediments which had accumulated to the west in a back-arc environment and to the east in a foreland basin that the Tejas epeiric sea flooded. According to Stille's (false)<sup>3</sup> concept that the culmination of an orogeny marks the end of a period, only Cordilleran orogenic events of Jurassic age should be included in the Nevadan orogeny. However, orogeny, being unconscious, pays no heed to such imaginatively defined period boundaries.

### Franciscan fm (a melange of Cretaceous and Upper Jurassic rocks)<sup>4</sup>

Its rocks are a thick (7,000 m) melange of graywackes, siltstones, black shales, cherts, pillow lavas, volcanic breccias, greenstones, and rare fossils (of radiolarians, clams, ammonites, and foraminifera). Part of the Franciscan fm which was subducting prior to its uplift between colliding terranes, are fine grained "blue schists" (often black colored rocks but so named for the glaucophane, a blue-black alkali-amphibole, in them). Before being raised, these were seafloor basalts that, carried down, were metasomatised (incorporating sodium from entrained seawater) at high pressure and low temperature.

### Sundance sea (Jurassic)

The Sundance sea flooded in from the northern Arctic foreland of North America. At full flood, its southern end, via Alberta, Canada, reached and occupied the western United States.

In the Late Jurassic, the Sundance sea was separated from the Pacific by emerging volcanic uplands and its western part deepened greatly. But twice, influxes of clastic sediments shed from the west forced the Sundance sea to retreat northeastward. So Sundance sea accumulations of minor evaporites and shallow-water marine sands and muds derived from the south and east, alternate with fluvial and lacustrine molasse conglomerates, sands and muds derived from the west. This whole Upper Jurassic formation, is called the *Morrison*.

The multicolored sediments of the Morrison fm are famous for being the world's richest repository of Jurassic dinosaur remains. However, its fossils are not easy pickings as the fm is well lithified. The

Morrison fm records an immense floodplain environment. The preservation by bacteria precipitated calcite mineralization of bones of turtles, crocodiles, and fish fossils not associated with marine shells, indicates once shallow lakes that were saline (probably due to rain-shadow semiaridity).

Most of the large Jurassic dinosaurs in museums come from the one million square kilometer area of the Morrison fm. Dinosaur bones, partly excavated but otherwise still embedded in the Morrison fm, are on display in the Morrison Natural History Museum, Dinosaur Valley Museum, Colorado, and the visitor's center of Dinosaur National Monument (opened in 1958) near Vernal, Utah.<sup>5</sup>

**Salt Wash member of the Morrison fm**

In the Colorado Plateau area, the Salt Wash member of the Morrison fm has economically significant uranium and vanadium content. The ore mineral is carnotite (hydrated potassium uranyl vanadate). This mineral (that has a highly-visible yellow color and is radioactive) occurs as a cement in stream-deposit facies and appears to have been introduced by mineral-bearing solutions that percolated through what were the more permeable of the sandstone and mudstone layers. Ore grade carnotite has been found in channel sandstones. Successful prospecting has been guided by these observations (**Figure g18.1**)<sup>6</sup> although the original source of this ore has not been located. □

**Figure g18.1**<sup>7</sup> The Morrison fm accumulated during the Late Jurassic in an interior sea that had come into being during the Middle Jurassic when the western margin changed to Andean- continental from marine. This change worked northward from far to the south, beginning in the Early Jurassic.

Rock facies (rock types) and isopach (thicknesses) maps of the Salt Wash member of the Morrison fm show fan-shaped patterns of deposition into a shared floodplain from two separate aggrading stream systems. The fans intertongue and intergrade along their common margin. A source southwest of south-central Utah for the Salt Wash sediments is indicated by paleocurrent directions (arrows on the map) and a lessening from there of clast size and formation thickness.

